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FINAL REPORT
EMI INSTRUMENTATION
REQUIRED FOR
THE EMCARD PROGRAM

REPORT NO. 79114
28 SEPTEMBER 1979

PREPARED FOR:
Naval Air Development Center
Warminster, PA
Contract No. N62269-79-M-6496

PREPARED BY:
R & B Enterprises
Plymouth Meeting, PA


Robert D. Goldblum
President

**IF YOU HAVE OR CAN FIND REQ'D INSTRUMENTS
PLEASE CONTACT JOE LANNON X3109
JOE SEGREST X2722**

R & B ENTERPRISES Division of Robar Industries Inc.
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FOREWORD

This is the final report of Contract Number N62269-7²M-6496. It contains the results of an effort to define MEC/EMI instrumentation required for the Navy's EMCARD program and MIL-STD-461A and 462 evaluations. The period of work performance under the contract extended from 13 Sept. 79 to 28 Sept. 79.

This report has been prepared to satisfy CDRL Data Item No. 1 following the format stated in A-5029.

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SECTION I

1.0 INTRODUCTION

The objective of this program is to determine the EMI instrumentation required by the Navy for testing in its EMCARD program and for MIL-STD-461A and MIL-STD-462 evaluations. This involved an inventory of available EMI instrumentation at NADC and research into the EMI instrumentation commercially available that will fulfill the stated requirements. The data has been compiled in tables from which recommendations have been made for the procurement of specific items. Costs (including GSA prices, when applicable) and delivery time have been included.

2.0 SUMMARY

Approximately 30 manufacturers of EMI test instrumentation and devices required in EMI test configuration have been contacted. The products of 25 of these manufacturers have been deemed appropriate for use in EMI and related tests. The required test equipment has been found to be commercially available with delivery dates generally ranging from stock to 6 months. In some limited cases, 12 month deliveries have been quoted. The only equipment not available as off-the-shelf equipment is the power amplification and radiation system required to produce 200V/M over the frequency ranges of 10kHz to 27GHz.

Tables have been developed showing the available EMI test instrumentation and products versus the applicable test requirements of MIL-STD-461A. A separate table is included for the test equipment required for MIL-HDBK-248 radiation hazards measurements.

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3.0 CONCLUSIONS

The EMI test instruments and products recommended for purchase by NADC have been divided into two categories: recommended bare minimum, and recommended preferred. These are presented in Tables 4 and 5 of Section II. The bare minimum includes the use of current NADC instrumentation, the manual operation of the instruments, limited redundancy in current probes and other devices, and limited back-up systems. The preferred list includes automatic operation of instrumentation, reasonable redundancy of certain products, and the availability of back-up and analysis equipment.

The current costs for the equipment are as follows:

Bare Minimum:

Preferred:

The costs represent current catalogue prices, GSA documents, where applicable, and many are substantiated by written quotes. It should be noted, however, that the prices are generally valid only for 90 days, and are subject to change at a later date.

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SECTION II

1. INTRODUCTION

This section includes a completed and detailed list of the recommended bare minimum and preferred EMI test equipment. It also describes the basis upon which the recommendations were made and other considerations.

2. OVERVIEW OF TABLES

2.1 TABLE 1

Table 1 is a list of EMI test instruments and products available to perform measurements to the requirements of MIL-STD-461A, Notices 1 and 2 per MIL-STD-462, Notices 1 and 2. In the preparation of this table, some preselection has been made, especially for products for which there are numerous sources, such as 10uf test capacitors. Cost, delivery and experience with the manufacturers' products were considerations in the preselection process.

The table shows the applicable MIL-STD-461/2 test method for which each product is required. It should be noted that a product may be applied on more than one test method in many cases.

The last column in Table 1 is the current price and delivery schedule for the corresponding product. Special GSA prices are shown, where applicable. These are all current prices taken from current price lists, and, in many cases, substantiated by written quotations. These quotations are retained in R & B Enterprises' files.

The number in the bracket following each manufacturer listed in the first column of Table 1 corresponds to the list of manufacturers shown in Table 6.

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2.2

TABLE 2

Table 2 is the list of EMI test instrumentation and products currently available at the Naval Air Development Center (NADC) in Warminster, PA. The equipment listed in this table forms the nucleus of the equipment which has been designated as bare minimum shown in Table 4. It also is a major part of extended capabilities offered by AILTECH as shown in Table 3.

2.3

TABLE 3

AILTECH has offered to modify NADC's existing NM-17/27 and NB-37/57 at no charge to make it part of complete automated receiving system. The additional equipment which must be purchased to complete this system is shown in Table 3. It should be noted that both Hewlett-Packard and Tektronix equipment form part of the AILTECH system.

The total price shown in Table 3 is \$166,112. This may be reduced substantially by deleting the extended range to 40GHz feature, FC-67, which costs \$50,000. However, AILTECH still wants to include the NM-67 receiver covering the frequency range of 1 to 18 GHz.

2.4

TABLE 4

Table 4 presents a list of recommended EMI test instrumentation and products which should be added to the current inventory of NADC equipment, as a bare minimum, in order to perform tests to most of the applicable requirements of MIL-STD-461A. It assumes that the entire testing operation will be manual, that there will be no duplication of products, such as current probes, antennas, etc. and that there will be no back-up system. The cost for this additional equipment is

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2.5 TABLE 5

Table 5 presents a list of recommended equipment which a fully equipped EMI test facility should have in order to perform EMI evaluations to MIL-STD-461/2. The automated features of this equipment provide considerable time and cost savings in the performance of the tests and the data reduction processes. It is not to be misconstrued as a "cadillac" facility since more expensive and complex measurement systems than those recommended exist.

2.6 TABLE 6

Equipment manufacturers which appear in all of the other tables of this report are consolidated and presented in Table 6. The addresses and telephone numbers are provided for the home offices. A comprehensive listing of local sales offices and sales representatives can be found in ITEM, EEM or other such directories.

2.7 TABLE 7

The prime sources of RF radiation hazard instrumentation are listed in Table 7, along with the measuring devices. The recommended device, manufactured by General Microwave is identified.

2.8 TABLE 8

The generation of 200 V/M across the radio spectrum of 10 kHz to 27 GHz is a very difficult and expensive proposition. Thus, the additional test equipment required to generate, radiate and measure these fields are separated and listed in Table 8.

3.0 DISCUSSION

The following discussion highlights some of the philosophy used in selecting the test equipment. Table 1 presents a large selection of EMI test instrumentation and products which are available. Tables 4 and 5 show the equipment which has been selected from Table 1.

The test instrumentation and products which NADC should have as a bare minimum are shown in Table 4. Even with this test equipment, there will still be tests per MIL-STD-461 for which equipment still is missing. The tests which cannot be performed are:

CS03

CS04

CS05

RE06

RS04

The reason these tests were omitted was in consideration of cost and the low frequency and priority in performing these tests. If it is desired to instrument to perform these tests, the required test equipment is shown in Table 1 and recommended in Table 5. RE06 instrumentation is not specified since it pertains to overhead power lines.

Special devices which must be built by the test laboratory, such as a long wire antenna, parallel plate, hand-held probes, etc. are not included. Other small devices, such as a step-down transformer, variac, etc. are not included since they are widely available, non-specialized and relatively low in cost.

The test instrumentation and products which the test facility should have to perform all tests per MIL-STD-461 are shown in Table 5. Whereas Table 4 assumes the use of present NADC

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equipment (Table 2), specifically, the Singer EMI receivers, Table 5 recommends the purchase of the Electro-Metrics' receiving system. The cost of upgrading the current system as shown in Table is approximately the same as the cost of the Electro-Metrics' system. Thus, the new acquisition provides redundancy and a back-up system at practically no additional cost.

The use of a spectrum analyzer to perform measurements above 1GHz is the preferred approach. The analyzer provides adequate sensitivity and very broad frequency coverage. It is also a useful tool in resolving interference problems, and provides some redundancy with the receivers.

The radiation hazard meter (Table 7) serves two functions. One is to perform measurement per MIL-HDBK-248, and secondly, to measure the RS03 field strengths above 200MHz. The field sensors will measure the RS03 fields below 200MHz. Thus, an extra set of antennas is not required and the receivers are free for other parallel tests.

The generation of 200 volts per meter from 10kHz to 27GHz is very expensive and involves unproven test methods. Table 8 is a list of test equipment currently identified for this type of test. Logimetrics has indicated that their system will provide the required fields. However, additional studies are recommended in this area prior to the commitment of funds.

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TABLE 1. TEST EQUIPMENT FOR TESTING TO MIL-STD-461A/462, NOTICES 1 and 2

MANUFACTURER	EQUIPMENT	MODEL	FREQUENCY RANGE	TEST METHOD																PRICE & DELIVERY
				CE01	CE02	CE03	CE04	CE05	CE06	CE07	CE08	RL01	RE02	RE03	RE04	RE05	RE01	RE02	RE03	
EMCO (1)	ANTENNA	3104	20MHz to 200MHz																	\$695. 45 days
	ANTENNA	3101	200MHz to 1000MHz																	\$750. "
	ANTENNA	3102	1GHz to 10GHz																	\$695. "
	ANTENNA	3106	200MHz to 2600MHz																	\$2650. "
	ANTENNA	3105	1GHz to 12.4GHz																	\$1495. "
ELECTRO-METRICS (2)	ANTENNA	3103	100MHz to 1000MHz																	\$1150. "
	ANTENNA	RVR-25	.014MHz to 30MHz																	\$990. 60 days
	ANTENNA	BIA-25	20MHz to 200MHz																	\$750. "
	ANTENNA	LCA-25	200MHz to 1000MHz																	\$750. "
	ANTENNA	RGA-50	1GHz to 12.4GHz																	\$1850. "
TENSOR (3)	ANTENNA	4104	20MHz to 200MHz																	\$485. 90 days
	ANTENNA	4101	200MHz to 1000MHz																	\$495. "
	ANTENNA	4102	1GHz to 10GHz																	\$485. "
	ANTENNA	4106	200MHz to 1500MHz																	\$2175. "
	ANTENNA	4105	1GHz to 12.4GHz																	\$1250. "
AILTECH (4)	ANTENNA	4103	100MHz to 1000MHz																	\$835. "
	ANTENNA	95010-1	10kHz to 40MHz																	\$750. 24 wks.
	ANTENNA	94455-1	20MHz to 200MHz																	\$595. 8 "
	ANTENNA	93490-1	200MHz to 1000MHz																	\$620. 72 "
	ANTENNA	93491-2	1GHz to 10GHz																	\$540. 18 "
ELECTRO-METRICS (2)	CURRENT PROBE	PCL-10	20Hz to 50kHz	X																\$300. 60 days
	CURRENT PROBE	PCL-25	10kHz to 110MHz		X															\$305. "
	CURRENT PROBE	91550-1	10kHz to 140MHz		X	X														\$225. 3 wks.
	CURRENT PROBE	91197-1	20Hz to 8MHz	X	X	X														\$205. "
	CURRENT PROBE	94111-1	1MHz to 1000MHz	X	X	X														\$300. "
FISCHER COMM.(5)	CURRENT PROBE	93686-2	30Hz to 50kHz	X																\$295. 12 wks.
	CURRENT PROBE	F-17	300Hz to 50kHz	X	X															\$450. 8 wks.
	CURRENT PROBE	F-11	300Hz to 50kHz	X	X	X														\$300. "
	CURRENT PROBE	F-12	2kHz to 2MHz	X	X	X														\$250. "
	CURRENT PROBE	F-14	300Hz to 50kHz	X	X	X														\$250. "
ELECTRO-METRICS (2)	RECEIVER	EMC-10	20Hz to 50kHz	X																\$8745. 60 days
	RECEIVER	EMC-25	10kHz to 1GHz	X	X															\$26,695 "
	RECEIVER	EMC-50	1GHz to 12.4GHz	X	X	X														\$39,950 90 days
	RECEIVER SYSTEM	FSS-250	20Hz to 1GHz	X	X	X														\$56,000 60 "
	RECEIVER SYSTEM	FSS-500	1GHz to 12.4GHz	X	X	X														\$49,400 90 "
ELECTRO-METRICS (2)	RECEIVER SYSTEM	FSS-750	20Hz to 12.4GHz	X	X	X														\$104,000 90 "
	RECEIVER SYSTEM	CCS-750	20Hz to 12.4GHz	X	X	X														\$115,795 90 "
	RECEIVER SYSTEM	CCS-125	20Hz to 1GHz	X	X	X														\$ 74,795 90 "

TABLE 1: TEST EQUIPMENT FOR TESTING TO MIL-STD-461A/462, NOTICES 1 and 2 (Continued)

MANUFACTURER	EQUIPMENT	MODEL	FREQUENCY RANGE	TEST METHOD													PRICE & DELIVERY
				CE01	CE02	CE03	CE04	CE06	CE08	CE09	CE10	CE11	CE12	CE13	CE14	CE15	
AILECH (4)	RECEIVER	NM-7A	20Hz to 50kHz	X													\$9056. 12 w
	RECEIVER	NM-7/27A	10kHz to 32MHz														\$14,470. 18
	RECEIVER	NM-37/57A	30MHz to 1GHz														\$17,230. 18
	RECEIVER SYSTEM	NM-67	1GHz to 18GHz														\$44,000. 30
WATKINS-JOHNSON (6)	RECEIVER SYSTEM	CP-7	20Hz to 18GHz	X													\$25,000. 18
	RECEIVER SYSTEM	WJ-8940B	5kHz to 18GHz	X													\$155,000. 18
HEWLETT-PACKARD (7)	SIGNAL SOURCE	200CD	5Hz to 600kHz														\$730. 24 w
	SIGNAL SOURCE	204D	4Hz to 2MHz														\$540. 11 "
	SIGNAL SOURCE	608B	50kHz to 65MHz														\$4500. 15 "
	SIGNAL SOURCE	608E	10Hz to 480MHz														\$5800. 9 "
	SIGNAL SOURCE	612A	450MHz to 1230MHz														\$4650. 9 "
	SIGNAL SOURCE	8614A	0.8GHz to 2.4GHz														\$4950. 17 "
	SIGNAL SOURCE	8616A	1.8GHz to 4.5GHz														\$4950. 21 "
	SIGNAL SOURCE	618C	3.8GHz to 7.6GHz														\$5850. 13 "
	SIGNAL SOURCE	620B	7GHz to 11GHz														\$5850. 16 "
	SIGNAL SOURCE	626A	10GHz to 15.5GHz														\$8650. 9 "
WAVETEK (8)	SIGNAL SOURCE	628A	15GHz to 21GHz														\$8650. 20 "
	SIGNAL SOURCE	166	.0001Hz to 50MHz														\$1695. 45 day
AILECH (4)	SIGNAL SOURCE	2002	1.0MHz to 2500MHz														\$3625. 12 wks
	SIGNAL SOURCE	445	10MHz to 2GHz														\$3400. (6SA)
KROHN-HITE (9)	SIGNAL SOURCE	4200	10Hz to 10MHz														\$2835. 6 wks
GENISCO (10)	CURRENT PROBE	SCP 5120/500	30Hz to 15MHz	X													\$550. 5 "
SOLAR (11)	TRANSFORMER	6220-1A	30Hz to 250kHz														\$99.50. 8 wks.
	CAPACITOR	7525-1	50kHz to 400MHz														\$36.50. 3 "
	FEEDTHRU	6512-106R	1kHz to 1GHz														\$59.50. 3 "
CAPTOR (12)	FEEDTHRU	10ufd/100A	1kHz to 1GHz	X													\$175. 8 "
FILTRON (13)	FEEDTHRU	ESR-710	1kHz to 1GHz	X													\$267. 10 "
HEWLETT-PACKARD(7)	ATTENUATOR	355D	DC to 1GHz	X													\$255. 9 "
	ATTENUATOR	355C	DC to 1GHz	X													\$255. 7 "
NARDA (14)	ATTENUATOR	771-6	(6dB) DC to 30GHz	X													\$40. 4 "

TABLE 1: TEST EQUIPMENT FOR TESTING TO MIL-STD-461A/462, NOTICES 1 and 2 (Continued)

MANUFACTURER	EQUIPMENT	MODEL	FREQUENCY RANGE	TEST METHOD																PRICE & DELIVERY
				CE01	CE02	CE03	CE04	CE05	CE06	CE07	CE08	RF01	RF02	RF03	RF04	RF05	RF01	RF02	RF03	
HEWLETT-PACKARD (7)	MAIN FRAME/DISPLAY	141T	Storage Scope																	\$2600
	IF SECTION	8552B																		\$4025
	RF SECTION	8556A	20Hz to 300kHz																	\$2525
	RF SECTION	8553B	1kHz to 110MHz																	\$3350
	RF SECTION	8555A	10MHz to 40GHz																	\$8100
	PRESELECTOR	8445B/002/003																		\$3930
	STORAGE NORMALIZER	8750																		\$1450
	OSCILLOSCOPE CAMERA	197B																		\$1100
	EXTERNAL MIXER	11517A	12.4 to 40GHz																	\$275
	WAVEGUIDE TAPER	11518A	12.4 to 18GHz																	\$175
TEKTRONIX (15)	SECTIONS	11519A	18 to 26.5GHz																	\$175
	"	11520A	26.5 to 40GHz																	\$175
	SPECTRUM ANALYZER	7L5	20Hz to 5MHz																	\$6650 2 wks.
	"	7L13	1kHz to 1800MHz																	\$9500 2 "
	"	491	10MHz to 40GHz																	\$11,500 18 "
	INPUT IMPEDANCE MODULE	L1	For 7L5																	\$600 2 "
	MAIN FRAME for 7L13		For 7L13																	\$3430 17 "
	SPECTRUM ANALYZER	72711	1MHz to 20GHz																	\$17,640 6 "
	SPECTRUM ANALYZER	757	1MHz to 22GHz																	\$19,975 12 "
	S.A. Camera	46																		\$450 6 "
GEN. MICROWAVE (25)	METER	4	.01 to 26GHz																	\$1250 26 "
NARDA (14)	METER	8608	.01 to 26GHz																	\$3645 16 "

TABLE 1: TEST EQUIPMENT FOR TESTING TO

MIL-STD-461A/462, NOTICES 1 and 2

(Continued)

MANUFACTURER	EQUIPMENT	MODEL	FREQUENCY RANGE	TEST LIMITS																				PRICE & DELIVERY	
				CE01	CE02	CE03	CE04	CE05	CE06	CS01	CS02	CS03	CS04	CS05	CS06	CS07	CS08	RF01	RF02	RF03	RF04	RF05	RF06		RF07
HEWLETT-PACKARD (7)	AMPLIFIER AMPLIFIER AMPLIFIER AMPLIFIER	489A	1GHz to 2GHz																					\$3850. 9 wks	
		491C	2GHz to 4GHz																					\$3850. "	
		493A	4GHz to 8GHz																					\$4200. "	
		495A	7GHz to 12.4GHz																					\$4200. "	
NARDA (14)	TWO-WAY POWER DIVIDER " "	3324-2	2 to 8GHz																					\$225 1 wk.	
		3326-2	6 to 18GHz																					\$350 10 wks.	
SOLAR (11)	LOW PASS FILTER "	6623-0.1	0 to 0.1MHz																					\$295 4 "	
		6623-0.2	0 to 0.2MHz																					\$295 4 "	
		6623-0.5	0 to 0.5MHz																					\$295 4 "	
		6623-1.0	0 to 1.0MHz																					\$295 4 "	
		6623-2.0	0 to 2.0MHz																					\$295 4 "	
		6623-5.0	0 to 5.0MHz																					\$295 4 "	
		6623-10	0 to 10MHz																					\$295 4 "	
		6623-20	0 to 20MHz																					\$295 4 "	
		6623-30	0 to 30MHz																						\$295 4 "
		6623-50	0 to 50MHz																						\$295 4 "
		6623-100	0 to 100MHz																						\$295 5 "
HEWLETT-PACKARD(?)	FREQUENCY COUNTER	5342A-H10	10Hz to 24GHz																				\$4850		
TEKTRONIX (15)	OSCILLOSCOPE, D. T. STORAGE OSCILLOSCOPE, PLUG-IN AMPLIF. " " TIME BASE OSC. CART OSCILLOSCOPE CAMERA	7613	0 to 100MHz																					\$3430 16 "	
		7A26	0 to 200MHz, Dual																					\$1435 6 "	
		7B53A																						\$1135 8 "	
		Model 3 C-53P																						\$375. 2 "	
AMERICAN ELECTRON- IC LABS, INC. (24)	ANTENNA	ASN-1232	200 to 1000MHz																					\$880 1 wk.	
HEWLETT-PACKARD(7)	ATTENUATOR	8491B-010	DC - 18GHz																					\$95	

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TABLE 1: TEST EQUIPMENT FOR TESTING TO MIL-STD-461A/462, NOTICES 1 and 2 (Continued)

MANUFACTURER	EQUIPMENT	MODEL	FREQUENCY RANG	TEST METHOD																								PRICL & DELIVERY		
				CE01	CE02	CE03	CE04	CE05	CE06	CS01	CS02	CS03	CS04	CS05	CS06	CS07	CS08	RF01	RF02	RF03	RF04	RF05	RS01	RS02	RS03	200V/H				
ELECTRO-METRICS (2)	NOTCH FILTER NOTCH FILTER	NRG-10 NRF-10	400Hz 60Hz	X X																										\$410. 90 days \$860. 90 "
SOLAR (11)	10MFD FEEDTHRU ISOLATION TRANSFORMER	6512-106R 7032-1	Power Line	X X	X X												X			X										\$60 1 wk. \$100. 3 wks.
ELECTRO-METRICS (2)	CURRENT PROBE AMP. TUNABLE REJECTION FILT.		14kHz to 220kHz 220kHz to 3500kHz 3.5MHz to 14MHz 14MHz to 110MHz 110MHz to 1000MHz	X																										\$425. 1 wk. \$17,000. 8 months
	HIGH PASS FILTER HIGH PASS FILTER	HPK-10 HPL-10	300Hz 2000Hz	X X																										\$595. 90 days \$450. 90 "
BIRD ELECTRONICS (22)	POWER ATTENUA- TOR (1kW)	8329	DC to 500MHz-30dB														X													\$890. 8 wks.
SOLAR (11)	AUDIO ISOLATION TRANSFORMER PHASE SHIFT NETWORK	6220-1A 7021-1	30Hz to 250kHz 60/400Hz	X																										\$165 6 wks. \$350. 1 wk.
BIRD ELECTRONICS (22)	DUMMYLOAD, 1KW	8251	DC to 1GHz																											\$340. 10 wks.
NARDA (14)	ATTENUATOR, 20W ATTENUATOR, 20W	768-3 768-10	DC to 11GHz DC to 11GHz																											\$140. 1 wk. \$140. "
BIRD ELECTRONICS (22)	COAX SWITCH	7431																												\$170. 4 wks.
NARDA (14)	COAX DIRECTIONAL COUPLER, 500 W 20 dB	3000-20	0.225 to 0.46 GHz																											\$200. 1 wk.
	" " " " " "	3001-20 3002-20 3003-20 3004-20 3039-20	0.46 to 0.95GHz 0.95 to 2.0GHz 2 to 4 GHz 4 to 10GHz 0.125 to 0.25GHz																											\$200. 2 wks. \$200. 10 wks. \$200. 1 wk. \$250. 8 wks. \$425. 1 wk.

TABLE 1: TEST EQUIPMENT FOR TESTING TO

MIL-STD-461A/462, NOTICES 1 and 2

(Continued)

MANUFACTURER	EQUIPMENT	MODEL	FREQUENCY RANG	TEST METHOD																PRICE & DELIVERY
HEWLETT-PACKARD (7)	DIGITAL VOLT-METER	3435A	10kHz to 700MHz		CE01															\$400. 11 wks.
	RF PROBE	11096			CE01	X														\$90. 2 "
IFI (16)	FIELD SENSOR	EFS-1	10kHz to 200MHz		CE01															\$545. Stock
	LIGHT TX	LMT	OPTICAL		CE01															\$495. "
	LIGHT RX	LDI	OPTICAL		CE01															\$495. "
AMPLIFIER RESEARCH (17)	LEVEL AMP	777	10kHz to 300MHz		CE01															\$950. 2 wks.
TOPAZ (18)	TRANSFORMER		60Hz ISOLATION		CE01	X	X	X												\$275. Stock
BERKLEY (19)	SIGNAL SOURCE	3020	SPIKE		CE01															\$249. (GSA)
					CE01															\$1645. 4 wks.
SOLAR (11)	SIGNAL SOURCE	6550-1	15Hz to 150kHz		CE01															\$1365. 3 "
	SIGNAL SOURCE	6254-1	SPIKE		CE01															\$845. 3 "
	AMPLIFIER	6552-1A	25Hz to 125kHz		CE01	X														\$750. 3 "
AMPLIFIER RESEARCH (17)	AMPLIFIER	100 L	10kHz to 220MHz		CE01															\$6700. 2 "
	AMPLIFIER	10W1000	1MHz to 1GHz		CE01															\$4900. 90 days
ENI (20)	AMPLIFIER	1040L	10kHz to 500kHz		CE01															\$2370. 60 "
	AMPLIFIER	A150	0.3MHz to 35MHz		CE01															\$3640. 60 "
	AMPLIFIER	440LA	150kHz to 300MHz		CE01															\$4500. 60 "
	AMPLIFIER	601L	800kHz to 1GHz		CE01															\$11,095. 60 "
IFI (16)	AMPLIFIER	M402	10kHz to 220MHz		CE01															\$7450. 30 "
AILTECH (4)	AMPLIFIER	5001	10kHz to 10MHz		CE01															\$2095. 8 wks.
	AMPLIFIER	5020	1 to 200MHz		CE01															\$4175. 8 "
	AMPLIFIER	35512	100 to 520MHz		CE01															\$6195. 8 "
	AMPLIFIER	15100	500 to 1000MHz		CE01															\$8625. 8 "
HUGHES (21)	AMPLIFIER	1177H09	1 GHz to 2GHz		CE01															\$5640. 60 days
	AMPLIFIER	1177H01	2GHz to 4GHz		CE01															\$5640. 60 "
	AMPLIFIER	1177H02	4GHz to 8GHz		CE01															\$5640. 60 "
	AMPLIFIER	1177H17	7GHz to 16.5GHz		CE01															\$7695. 60 "

TABLE 2

EMI TEST EQUIPMENT CURRENTLY AVAILABLE AT NADC

DESCRIPTION	MODEL	MANUFACTURER
EMI Field Intensity Meter	NM-17/27	Singer Stoddard
EMI Field Intensity Meter	NB-37/57	Singer Stoddard
41" Rod Antenna	92197-3	Singer
Antenna Coupler	94592-1	Singer
Bi-Conical Antenna	7825	Honeywell
Bi-Conical Antenna	BCA-902	Honeywell
Conical Log Spiral Antenna	93490-1	Singer
Current Probe	91550-1	Stoddard
Tripod	91933-2	Singer
Transmission Cable, 20"	92191-1	Singer
H-Y Recorder	7047A	Hewlett-Pickard
Line Stabilization Networks (3)	- -	- -
Loop Probe	90799-3	Singer
Impulse Generator	IG-115	Empire Devices

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TABLE 3
 AILTECH EQUIPMENT REQUIRED TO EXTEND
 CAPABILITIES OF PRESENT NADC EQUIPMENT

MANUFACTURER	EQUIPMENT	MODEL	UNIT PRICE	TOTAL PRICE	DELIVERY
AILTECH	CONTROL UNIT	CP-7	\$25,000	\$25,000	18 weeks
	20Hz - 50kHz	NM-7A	9,560	9,560	12 "
	1-18GHz	NM-67	44,000	44,000	30 "
	Extend range to 40GHz; price not to exceed	FC-67	50,000	50,000	1 year
	INPUT SWITCH w. atten.	CIV-7	5,900	5,900	30 weeks
HEWLETT-PACKARD	CALCULATOR	9825F	9,000	9,000	18 "
	DIGITAL PLOTTER	9862.015	3,980	3,980	18 "
TEKTRONIX	OSCILLOSCOPE		3,400	3,400	18 "
AILTECH	LOOP ANTENNA 5 $\frac{1}{4}$ "d./NM-7	94605-1	235	235	12 "
	B.B. ANTENNA Preamp/Coupler	94607-1	500	500	8 "
	Biconical Antenna 20-200MHz	94455-1	595	595	8 "
	Log Periodic Antenna, 1-18GHz	94612-1	750	750	26 "
	Curr. Probe 20Hz-8MHz	91197-1	205	205	10 "
	Curr. Probe 1MHz-1GHz	94111-1	300	300	10 "
	Curr. Probe 20Hz-50MHz	93686-2	295	295	10 "
	BNC to N ADAPTER (2 ea.)	11663	6.50 ea.	13.	10 "

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TABLE 3 (Cont'd.)

MANUFACTURER	EQUIPMENT	MODEL	UNIT PRICE	TOTAL PRICE	DELIVERY
AILTECH	CABLE 6', N-N	90933-6	\$ 75	\$ 75	10 weeks
	CABLE 20', N-N 2 ea.	90933-8	100	200	10 "
	CABLE 20' BNC-BNC	92191-1	45	45	10 "
	PROGRAM CABLE, 6'-4 ea.	94595-1	320	1280	10 "
	CABLE RF to VIDEO 8 ea.	94596-1	33	254	10 "
	CONTROL CABLE	94604-1	175	175	10 "
	CABLE-IEEE-488 10'	94618-2	185	185	10 "
	Cable -IEEE to Calculator	98034A	470	470	10 "
	TRIPOD ADAPTER, 2 ea.	91932	95	190	10 "
	TRIPODS, 2 ea.	91933-2	210	420	10 "
	GROUND PLANE	92199-3	90	90	10 "
	HEADPHONES	10796-2	33	33	10 "
	2 BAY CONSOLE/ DECK/STORAGE DRAWER (WIRED)		2700	2700	10 "
	ROLLAWAY CABINET WIRED FC67		1200	1200	10 "
	WAVEGUIDE for 18GHz-40GHz Ant.		300	300	10 "
	18-40GHz Ant.		750	750	10 "
	HORN ANTENNA KIT, 1-18GHz	94623-1	3575	3575	10 "
	HORN TRANSIENT CASE, 2 ea.	94621-1	225	450	10 "
		TOTAL PRICE		\$166,112	

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TABLE 4
RECOMMENDED ADDITIONAL EQUIPMENT
(BARE MINIMUM)

QUANTITY	MANUFACTURER	EQUIPMENT	MODEL	TOTAL PRICE
1	TENSOR (3)	ANTENNA	4105	\$1250
1	AILTECH (4)	CURRENT PROBE	91197-1	\$205
1	SOLAR (11)	CAPACITOR	7525-1	\$36.50
4		10MFD CAPACITOR	6512-106R	\$240.
2		ISOLATION XFMR	7032-1	\$200
1		AUDIO ISOLATION XFMR	6220-1A	\$165
1		SPIKE GENERATOR	7054-1	\$1450
1		0.5 ohm RESISTOR	6920-0.5	\$88
1		AMPLIFIER	6552-1A	\$750
1	HEWLETT-PACKARD (7)	ATTENUATOR	355D	\$255
1		SIGNAL SOURCE	8616A	\$4950
1		" "	618C	\$5850
1		" "	620B	\$5850
1		" "	626A	\$8650
1		" "	628A	\$8650
1		DIGITAL VOLTMET.	3435A	\$400
1		RF PROBE	11096	\$90
1		AMPLIFIER	489A	\$3850
1		"	491C	\$3850
1		"	493C	\$4200.
1	WAVETEK (8)	SIGNAL SOURCE	166	\$1695
1		" "	2002	\$3400
1	IFI (16)	FIELD SENSOR	EFS-1	\$545

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TABLE 4 (Continued)

QUANTITY	MANUFACTURER	EQUIPMENT	MODEL	TOTAL PRICE
1	AMPLIFIER RESEARCH (17)	LEVEL AMP	777	\$950
1		AMPLIFIER	100L	\$6700
1		"	10W1000	\$4900
1	HUGHES (21)	AMPLIFIER	1177H17	\$7695
1	BIRD ELECTRONICS (22)	ATTENUATOR	8329	\$890
1		DUMMYLOAD	8251	\$340
1		COAX SWITCH	7431	\$170
1	NARDA (14)	DIRECT. COUPLER	3000-20	\$200
1		"	3001-20	\$200
1		"	3002-20	\$200
1		"	3003-20	\$200
1		"	3004-20	\$250
1		"	3039-20	\$425
1	MICROLAB (23)	POWER DIVIDER	DA-3FN	\$55
1	ELECTRO-METRICS (2)	NOTCH FILTER	NRG-10	\$410
1		" "	NRF-10	\$860
1		TUNABLE REJ. FILTERS	TRF-13	\$4200
1		" "	TRF-14	\$3700
1		" "	TRF-15	\$3400
1	GENERAL MICROWAVE (25)	METER	4	\$1250
1	HEWLETT-PACKARD (7)	SPECTRUM ANALYZER	141T	\$2600
1		IF SECTION	8552B	\$4025
1		RF SECTION	8553B	\$3350
1		" "	8555A	\$8100
1		PRE-SELECTOR	8445B	\$3930
TOTAL COST				\$110,434.50

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TABLE 5

RECOMMENDED ADDITIONAL EQUIPMENT
(PREFERRED)

QUANTITY	MANUFACTURER	EQUIPMENT	MODEL	UNIT PRICE	TOTAL PRICE
1	TENSOR	ANTENNA	4104	\$485	\$485
1		ANTENNA	4101	\$495	\$495
1		ANTENNA	4105	\$1250	\$1250
1	ELECTRO-METRICS	CURRENT PROBE	PCL-10	\$300	\$300
1			PCL-25	\$305	\$305
1		RECEIVER SYSTEM	CCS-125	\$74,795	\$74,795
2	HEWLETT-PACKARD	SIGNAL SOURCE	200CD	\$730	\$1460
2		"	204D	\$540	\$1080
2		"	606B	\$4500	\$9000
2		"	608E	\$5800	\$11,600
2		"	612A	\$4650	\$9,300
2		"	8614A	\$4950	\$9,900
2		"	8616A	\$4950	\$9,900
2		"	618C	\$5850	\$11,700
2		"	620B	\$5850	\$11,700
2		"	626A	\$8650	\$17,300
2		"	628A	\$8650	\$17,300
1	SOLAR	TRANSFORMER	6220-1A	\$99.50	\$99.50
1		CAPACITOR	7525-1	\$36.50	\$36.50
4		FEEDTHRU	6512-106R	\$59.50	\$238

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TABLE 5 (Continued)

QUANTITY	MANUFACTURER	EQUIPMENT	MODEL	UNIT PRICE	TOTAL PRICE
1	HEWLETT-PACKARD (7)	ATTENUATOR	355D	\$255	\$255
1			355C	\$255	\$255
2	NARDA	(14) ATTENUATOR	771-6	\$40	\$80
1	HEWLETT-PACKARD (7)	DIGITAL VOLT METER	3435A	\$400	\$400
1			RF Probe	\$90	\$90
1	IFI	(16) FIELD SENSOR	EFS-1	\$545	\$545
1			LIGHT TX	\$495	\$495
1			LIGHT RX	\$495	\$495
1	SOLAR	(11) SIGNAL SOURCE	6254-1	\$845	\$845
1			AMPLIFIER 6552-1A	\$750	\$750
1	AMPLIFIER RESEARCH (17)	AMPLIFIER	100 L	\$6700	\$6700
1			10W1000	\$4900	\$4900
1	HUGHES (21)	AMPLIFIER	1177H09	\$5640	\$5640
1			1177H01	\$5640	\$5640
1			1177H02	\$5640	\$5640
1			1177H17	\$7695	\$7695
1	ELECTRO-METRICS (2)	NOTCH FILTER	NRG-10	\$410	\$410
1			NRG-10	\$860	\$860
2	SOLAR	(11) ISOLATION TRANSFORMER	7032-1	\$100	\$200

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TABLE 5 (Continued)

QUANTITY	MANUFACTURER	EQUIPMENT	MODEL	UNIT PRICE	TOTAL PRICE
1	ELECTRO-METRICS	(2) CURRENT PROBE AMP.		\$425	\$425
1		TUNABLE REJECTION	TRF-11		
1		FILT.	TRF-12		
1			TRF-13		
1			TRF-14		
1			TRF-15		\$17,000
1		HIGH PASS	HPK-10	\$595	\$595
1		FILTER	HPL-10	\$450	\$450
1	BIRD ELECTRONICS	(22) POWER ATTENUA- TOR (1kW)	8329	\$890	\$890
1	SOLAR	(11) PHASE SHIFT NETWORK	7021-1	\$350	\$350
1	BIRD ELECTRONICS	(22) DUMMY LOAD, 1kW	8251	\$340	\$340
2	NARDA	(14) ATTENUATOR, 20W	768-3	\$140	\$280
2		ATTENUATOR, 20W	768-10	\$140	\$280
1	BIRD ELECTRONICS	(22) COAX SWITCH	7431	\$170	\$170
1	NARDA	(14) COAX DIRECTIONAL COUPLER, 500W 20dB	3000-20	\$200	\$200
1		"	3001-20	\$200	\$200
1		"	3002-20	\$200	\$200
1		"	3003-20	\$200	\$200
1		"	3004-20	\$250	\$250
1		"	3039-20	\$425	\$425

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TABLE 5
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QUANTITY	MANUFACTURER	EQUIPMENT	MODEL	UNIT PRICE	TOTAL PRICE
1	MICROLAB (23)	POWER DIVIDER 2 Watt	DA-3FN	\$55	\$55
1	SOLAR (11)	LLOOP SENSOR	7334-1	\$195	\$195
1		RESISTOR, NON-INDUCTIVE	6920-0.5	\$88	\$88
1		"	6815-1	\$185	\$185
1		TWO-WAY POWER DIVIDER	3324-2	\$225	\$225
1	NARDA (14)		3326-2	\$350	\$350
2	SOLAR (11)	LOW PASS FILTER	6623-0.1	\$295	\$590
2		"	6623-0.2	\$295	\$590
2		"	6623-0.5	\$295	\$590
2		"	6623-1.0	\$295	\$590
2		"	6623-2.0	\$295	\$590
2		"	6623-5.0	\$295	\$590
2		"	6623-10	\$295	\$590
2		"	6623-20	\$295	\$590
2		"	6623-30	\$295	\$590
2		"	6623-50	\$295	\$590
2		"	6623-100	\$295	\$590
1	HEWLETT-PACKARD (7)	FREQUENCY COUNTER	5342A-H10	\$4850	\$4850
1	TEKTRONIX (15)	OSCILL., D.T. STORAGE	7613	\$3430	\$3430
1		OSCILL., PLUG- IN AMPLIF.	7A26	\$1435	\$1435
1		PLUG-IN TIME BASE	7B53A	\$1135	\$1135
1		OSCILL. CAMERA	C-53P	\$1225	\$1225

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QUANTITY	AMMANUFACTURER	EQUIPMENT	MODEL	UNIT PRICE	TOTAL PRICE
2	HEWLETT-PACKARD (7)	ATTENUATOR	8491B-010	\$95	\$190
1	AMERICAL ELECTRONIC LABS, INC. (24)	ANTENNA	ASN-1232	\$880	\$880
1	HEWLETT-PACKARD (7)	MAIN FRAME/ DISPLAY	141T	\$2600	\$2600
1		IF SECTION	8552B	\$4025	\$4025
1		RF SECTION	8556A	\$2525	\$2525
1		" "	8553B	\$3350	\$3350
1		" "	8555A	\$8100	\$8100
1		PRESELECTOR	8445B/002/ 003	\$3930	\$3930
1		STORAGE NORMALIZER	8750	\$1450	\$1450
1		OSCILLOSCOPE CAMERA	197B	\$1100	\$1100
1		EXTERNAL MIXER	11517A	\$275	\$275
1		WAVEGUIDE TAPER SECTIONS	11518A	\$175	\$175
1		" "	11519A	\$175	\$175
1		" "	11520A	\$175	\$175
1	GENERAL MICROWAVE (25)	METER	4	\$1250	\$1250
1	ELECTRO-METRICS (2)	ANTENNA	RVR-25	\$990	\$990
TOTAL PRICE					\$303,247.00

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TABLE 6
EQUIPMENT MANUFACTURER
LOCATION

- | | |
|---|--|
| <p>(1) The Electro-Mechanics Co. (EMCO)
P. O. Box 1546
Austin, TX 78767
512-451-8273</p> | <p>(9) KROHN-HITE Corp.
Avon Industrial Park
Bodwell St.
Avon, MA 02322
617-580-1660</p> |
| <p>(2) Electro-Metrics
100 Church St.
Amsterdam, NY 12010
518-843-2600</p> | <p>(10) Genisco Technology Corp.
18435 Susana Rd.
Compton, CA 90221
213-537-4750</p> |
| <p>(3) Tensor, Inc.
P. O. Box 14843
Austin, TX 78761
512-837-4900</p> | <p>(11) Solar Electronics Co.
901 N. Highland Ave.
Hollywood, CA 90038
213-462-0806</p> |
| <p>(4) AILTECH
Los Angeles Operation
5340 Aila Rd.
Los Angeles, CA 90066
213-822-3061</p> | <p>(12) Captor Corporation
5040 S. County Rd. (25A)
Tipp City, OH 45371
513-667-8484</p> |
| <p>(5) Fischer Custom Communications
P. O. Box 581
Manhattan Beach, CA 90266
213-545-4617</p> | <p>(13) Filtron Mfg. Co., Inc.
148 Sweet Hollow Rd.
Old Bethpage, NY 11804
516-752-1144</p> |
| <p>(6) Watkins-Johnson Co.
700 Quince Orchard Rd.
Gaithersburg, MD 20760
301-948-7550</p> | <p>(14) Narda Microwave Corp.
75 Commercial St.
Plainview, NY 11803
516-433-9000</p> |
| <p>(7) Hewlett-Packard Co.
1021 Eight Ave.
King of Prussia, PA 19406
215-265-7000</p> | <p>(15) Tektronix, Inc.
P. O. Box 500
Beaverton, OR 97077
503-644-0161</p> |
| <p>(8) Wavetek
66 North First Ave.
Beech Grove, IN 46107
317-783-3211</p> | <p>(16) Instruments for Industry, Inc.
151 Toledo St.
Farmingdale, NY 11735
516-694-1414</p> |

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TABLE 6 (Cont'd.)

- | | |
|---|--|
| <p>(17) Amplifier Research Corp.
160 School House Rd.
Souderton, PA 18964
215-723-8181</p> | <p>(27) EPSCO Microwave
411 Providence Hwy.
Westwood, MA 02090
617-329-1500</p> |
| <p>(18) Topaz Electronics
3855 Ruffin Rd.
San Diego, CA 92123</p> | <p>(28) Logimetrics, Inc.
121-03 DuPont St.
Plainview, NY 11803
516-681-4700</p> |
| <p>(19) Berkeley Instruments, Inc.
2700 DuPont Dr.
Irvine, CA 92715</p> | |
| <p>(20) Electronic Navigation Industries, Inc.
3000 Winton Rd.
So. Rochester, NY 14623
716-473-6900</p> | |
| <p>(21) Hughes Aircraft Co.
Electron Dynamics Div.
3100 W. Lomita Blvd.
Torrance, CA 90509
213-534-2121</p> | |
| <p>(22) Bird Electronics Corp.
30303 Aurora Rd.
Solon, OH 44139
216-248-1200</p> | |
| <p>(23) Microlab/FXR
10M Microlab Rd.
Livingston, NJ 07031
201-992-7700</p> | |
| <p>(24) American Electronic Labs, Inc.
P. O. Box 552
Lansdale, PA 19446
215-822-2929</p> | |
| <p>(25) General Microwave Corp.
155 Marine St.
Farmingdale, NY 11735
516-694-3600</p> | |
| <p>(26) BEC Engineers, Inc.
625 Andover Park West
Tukwila, WA 98188
206-575-5772</p> | |

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TABLE 7
RADIATION HAZARD MONITORING INSTRUMENTS

MANUFACTURER	EQUIPMENT	MODEL	FREQUENCY RANGE	PRICE	DELIVERY
NARDA MICROWAVE (14)	METER	8608	0.01 to 26GHz		
	PROBE	8621	0.3 to 26GHz 10 to 300MHz 0.3 to 26GHz 10 to 300MHz	\$3645	16 weeks
	PROBE	8631		\$1450	18 weeks
	PROBE	8623		\$975	12 weeks
	PROBE	8633			
*GENERAL MICROWAVE(25)	METER	4	0.01 to 26GHz	\$1250	26 weeks

*Recommended because of price.

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TABLE 8
EQUIPMENT FOR 200V/M SUSCEPTIBILITY TEST

MANUFACTURER	EQUIPMENT	MODEL	FREQUENCY RANGE	POWER	PRICE	DELIVERY
AMPLIFIER RESEARCH (17)	POWER AMPLIF.	AR2000L	10kHz to 220MHz	2kW	\$38,000	4 months
	"	AR900	10kHz to 100MHz	10kW	\$75,000	9 "
	"	AR200HA	220 to 400MHz	200W	\$15,900	4 "
EPSCO MICROWAVE (27)	POWER SOURCE	5233H/B3	450 to 950MHz	5kW Pulse	\$7000	8 weeks
LOGIMETRICS (28)	POWER AMPLIF.	A600/L	1 to 2GHz	200W	\$20,000	150 days
	"	A600/S	2 to 4 GHz	200W	\$18,500	" "
	"	A600/C	4 to 8GHz	200W	\$18,500	" "
	"	A600/X	8 to 12.4GHz	200W	\$19,000	" "
	"	A600/U	12.4 to 18GHz	100W	\$30,500	" "
AMPLIFIER RESEARCH (17)	ANTENNA	AT1000	150 to 1000MHz		\$1850	60 "
TENSOR (3)	RIDGED WG. ANT.	4105	1 to 12.4GHz		\$1250	90 days
AMERICAN ELECTRONIC LABS, INC. (24)	LOG PERIODIC ANTENNA					
	TEM TEST CELL		10kHz to 100MHz		\$1- 3,000,000	
BOEING (26)	200V/M SYSTEM COMPLETE-INS- TALLED W/REMOTE CONTROL	1018R	10kHz to 27GHz	200V/M at 1 Meter	\$600,000	1 year
LOGIMETRICS (28)	200V/M SYSTEM COMPLETE-INS- TALLED COMPUTER CONTROL W/ SOFTWARE	1018C	10kHz to 27GHz	200V/M at 1 meter	\$850,000	1 year

R & B ENTERPRISES

Division of Robar Industries Inc.

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